NEEDS OF MICROTECHNOLOGIES FOR MICROSURGERY MICROSURGEONS MAKE EASY MICROTECHNIQUES

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Abstract-**Microsurgery is a specialized technical discipline in Surgical Clinics; microsurgical strategies and performances are dedicated to solve clinical and surgical complex problems, working on conductive structures or on compartmentalized miniaturized organs and structures; the working conditions in which Microsurgery is applied requires more sophisticated approaches in the classical tool action-tissue reaction response loop. Microtechnologies permit to develop more promising microtechniques, but their application or their efficacy in the microsurgical field is not so obvious or trivial. The target-oriented surgical strategies can help to focalize the microtechnical goals, design and configuration for a valuable performance in the surgical theatre. Microtechnologies and Microtechniques must be introduced in Microsurgery in harmony with the new strategies of minimally invasive and micro-invasive, control system, computer-assisted, driven procedures. Microsurgeons can make easy microtechniques, evaluating cost-benefit in the health-care clinical platform, orienting the technological investments and the research projects of specific technical solutions.**

BACKGROUND

Microsurgery is a technical discipline in Surgical Clinics, as Minimally Invasive Surgery (MIS) or Laparoscopy or Endoscopy, and is focused on a specific biological range, defined –**micro-** in surgical terms. (1)

The Microsurgical Dimension

The Microsurgical Dimension is clearly defined as a transition zone between the limit of the human eye vision and the classic optic microscope used to observe fixed samples of tissue as in the histo-pathology. This empiric evidence-based definition in practical terms and the need to operate in this transition zone obliged to develop a new optic instrument, called **operating microscope**, permitting to perform specific actions at that level.

Basic biological structures can be handled in the transition zone: nerves, vessels (arterial, venous) and lymphatics, tubular structures functioning as conducting channels for fluids and cells, special compartmentalized complex organs and apparatus as the eye and the ear. A lot of microsurgical techniques are developed to suture and repair nerves and vessels, but also to perform specific operations in the compartments of the eye and of the ear. Plastic reconstructive surgery and neurosurgery take advantage of this technical background to develop new surgical approaches as pedicled free tissue transplantations, stereotaxis microneurosurgery, microsurgery of male and female infertility. The operating microscope is progressively modified to adapt to the needs of specific disciplines in terms of working distance, degree of freedom and ergonomics in the operating theatre. Instrumentation of Microsurgery is developed on simple bases, using miniaturization principles of classic instruments (scissors, needle holder etc.); a large spectrum of specific shapes of microinstruments is realized in specific areas, as surgery of the eye and of the ear, and special approximators with micro-clamps for suturing nerve and vessels are realized.

Specialized Reconstructive Microsurgeries

The non-classical areas of Microsurgery (Special Reconstructive Microsurgery) are developed in the second phase showing the need to work microsurgically in a different way: working in a plane was well adapted for animal lab microsurgical experiments, but it encounters a great difficulty to be applied on humans in the operating theatre in which three-dimensional working volume is managed: curved or irregular surface profiles or deep targets impose new strategies and new instrumentations.

All the problems obseerved in Macro-Surgery to evaluate the performance of the surgical act are reported in the micro-surgical scale, with the constraints linked to the new visual field, without any tactile sensing or active measurement system.

Astonishingly operators emphasize the miracle of the magnification of the human vision with the O.M.; but in reality in the transition zone the O. M. is the real eye for the surgeon in this range.

The constrained and restrained vision linked to the O.M. and to the dimension of the biological structures handled under O.M. imposed a more structured educational and training program, a slow learning curve in the experimental lab, and a specific surgical plan. The ergodynamics of the body motion and hands degree of freedom of the surgeon is changing and obliges to a psycho-physical effort in terms of mental concentration, eye fatigue, back and neck pain, and control of the fine tremor of the hands, never observed before in classical open surgery.

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Psychodynamics of the microsurgical performance and musculo-skeletal body motion control sustain a more complex approach to guarantee the real performance and benefit of a microsurgical procedure: the evidence-based principle is not evident when applied in a classical way to evaluate a surgical performance. The needs to quantify and to measure the biological parameters involved in the microsurgical operation on one side and to support ergonomically the psycho-physical effort of the microsurgeon on the other side are really the new goals of this discipline.

MICROTECHNOLOGY AND MICROSURGERY

The role of the Microtechnologies

Microtechnologies and Microsystems are a new emerging technological area in Biomedical Engineering.

The large scale of dimensions of the proposed systems is creating fantastic expectations with an idealistic equation that micro is beautiful, micro is better than macro, micro is more efficient.

Microtechnology is a more complex phenomenon in applicative sciences, because on one side it is expression of the potentialities of the technological industries and manufacturing, on the other side it opens a new frontier in the discover and analysis of new biophysical phenomena at the micro-scale.

FUTURE PERSPECTIVES

Microtechnologies can be applied to Microsurgery at different levels:(2)

*Microinstruments as passive tools or transformed in active actuators (micromechatronic tools)

*Microsensors as simple microinformation channels or interactive bionformation perceptrons

***Intelligent Microsystems (IMIS)** implying special control system technologies on which dedicated microtechnologies can be implemented.(3)

All these ranges of application must fit the realistic goals of the microsurgeon to improve the surgical performance in real-time, to increase the level of efficiency of the microsurgical task and to justify the cost - benefit linked to the innovative **IMIS** " intelligent" technologies versus the "simple" non-linear behaviour of the human manual action.

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